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## Memo

*DATE:* November 7, 2003

*TO:* RHIC E-Coolers

*FROM:* *Ady Herscovitch*

*SUBJECT:* **Minutes of the November 7, 2003 Meeting**

Present: Ilan Ben-Zvi, Andrew Burrill, Xiangyun Chang, Yury Eidelman (ORNL & BINP Novosibirsk, Russia), Alexei Fedotov, Ady Herscovitch Vladimir Litvinenko, Derek Lowenstein, William Mackay, Thomas Roser, Alexander Smirnov (JINR Dubna Russia), Triveni Srinivasan-Rao, Dejan Trbojevic, Jie Wei.

Topics discussed: High Current Energy Recovery LINAC, 939 Setup, Building 912, E-Cooler Electron Beam and Plasma Stability, E-RHIC.

**High Current Energy Recovery LINAC:** Ilan opened the meeting reporting on a new research opportunity with navy funding to develop a superconducting photoinjector with a multi-alkaline photocathode. There is a high risk factor associated with a possible degradation of the superconducting cavity due to migration of alkaline atoms from the cathode to the niobium surface. Such migration, driven by the laser light, may cause field emission in the cavity. There is no information on this subject. A small, risk-reduction experiment may be done at our cathode development stand.

**939 Setup:** in an answer to Thomas' question on the status of the superconducting electron gun, Triveni replied that it is still at Jefferson Laboratory awaiting cleaning. There is a big delay due to various problems and scheduling priorities in the cleaning program at Jefferson Laboratory. Since our superconducting electron gun has a much lower priority than SNS e.g., there is no reason to "push" Jefferson Laboratory on this matter. More safety work is being performed at Building 939. We hope to have the superconducting electron gun operational in early December.

Regarding the photocathode, Andrew Burrill said that experiments in the deposition system show that a quantum efficiency of 2.5% is being reached. However it drops with time to 1.5%. Experiments now conducted are aimed to sustain the higher level. In one such experiment attempts are made to stop the deposition while the quantum efficiency is still rising.

**Building 912:** Derek told Ilan that a layout of building 912 is needed. Ilan replied that the layout is being prepared. A discussion ensued regarding the move to building 912. Derek

pointed out that it is critically important to complete the move before the next shutdown due to the availability of personnel.

**E-Cooler Electron Beam and Plasma Stability:** Ady reported on a talk he gave last week at the APS DPP meeting regarding electron beam induced velocity space and other plasma microinstabilities due to electron beam cooling in RHIC. Potential for instabilities exists in plasmas that are inhomogeneous. In our case there are density gradients and anisotropic temperatures. Ady's analysis reveals that none of these microinstabilities have sufficient conditions to occur. Some people from LLNL claimed (at the conference) that some of those instabilities have been observed in heavy ion fusion devices. Ady pointed out that the RHIC E-Cooler parameters are very different from those of heavy ion fusion drivers. Alexei said that Parkhomchuk has already done microstability analysis. Ady replies that the RHIC E-Cooler stability analysis Parkhomchuk performed involves macroscopic oscillations of ion and electron bunches. By its nature this is macroscopic stability.

After the talk Paul Channell from LANL questioned the accuracy and reproducibility of the planned cooler electron beam, i.e., there will be mismatch in the drift velocities of ion and electron bunches. He claimed that we would be unable to achieve better than 1%. In this case, he asserted, the two stream instability can occur (it would actually be the Buneman instability, which has a low density threshold). Ilan joked that in this case, electron beam cooling will not work either. Ilan and Vladimir claimed that the stability of superconducting LINACs driven by laser ion sources is in the ppm range or better. We plan to have feedback systems that will ensure it. Ilan said that Jean Delany, who's an expert on these controls, was invited to give a talk at BNL.

Finally Ady pointed out there is a potential for flaw in Parkhomchuk's (and others like Bosser) stability analysis for electron beam coolers. Mathematically their stability analysis was set up as a "classical anharmonic oscillator." In a book by Osrzag and Bender (based on works by Kolmogoroff, Cole, as well as Bogoliubov & Mitroposky) on this topic, it is shown that time secularities can appear due to a mathematical art-effect in perturbation theory, where a lower order term can drive a higher order equation at the resonant frequency. To ensure that this does not occur, a two time scale analysis must be performed. Nevertheless, Parkhomchuk's work may still have generated the correct results.

**E-RHIC:** Vladimir asked Thomas about achieved parameters that can be expected for E-RHIC. Thomas and Waldo replied that single bunches of  $2 \times 10^{11}$  protons have been demonstrated. However 360 bunches will exceed the accelerator safety limit. In the case of gold,  $2 \times 10^9$  gold ions per bunch has not been demonstrated. Present plans call for electron beam energy range in E-RHIC of 5 – 10 GeV. To Vladimir question on whether the electron beam energy range should be extended to down to 2 GeV, Thomas replied yes.